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DEVELOPMENT OF THE SAND AND GRAVEL INDUSTRY

BY

SHIRLEY F. COLBY

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DEVELOPMENT OF THE SAND AND GRAVEL INDUSTRY 1/

By Shirley F. Colby 2/

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INTRODUCTION

The past 40 years have seen the sand and gravel industry grow from small roadside pits and holes in farmers' back yards to giant corporations selling millions of tons of sand and gravel each year and owning plants representing huge capital investments in land and equipment. The days when a man could "work out" his taxes by providing the materials for nearby roads are gone forever. In addition to the hundreds of privately owned and operated plants, Government agencies operate sand and gravel pits and plants to supply aggregates for the tremendous road-building and public-works programs in progress during the past few years.

EXPANDING PRODUCTION

In 1940 the sand and gravel industry produced almost a quarter of a billion short tons valued at more than 110 million dollars. This compares with less than 2 million short tons worth 1 1/2 million dollars produced in 1902. The practice of screening sand and throwing away the gravel in the early days of the industry's growth has stopped, and in 1940 gravel constituted two-thirds of the total production. In 1906, the first year in which sand and gravel were reported separately, gravel accounted for only one-

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fourth of the total. In those early days sand was used extensively in building construction, as engine sand, for manufacturing glass, and for various other purposes for which it is still employed; but gravel was in small demand until an oncoming cement age created enormous demands for aggregates.

A break-down of production of sand and gravel by commercial and noncommercial operations since 1923 is given in table 1. A more detailed analysis of noncommercial production is presented each year in the Sand and Gravel chapter of Minerals Yearbook, published by the Bureau of Mines. Minerals Yearbook Review of 1938 contains a table showing noncommercial production of sand and of gravel separately and is further divided to show building and paving. Noncommercial sand and gravel represents that reported by States, counties, municipalities, and other Government agencies produced by their own construction or maintenance crews or by contractors expressly for their consumption but does not include purchases from commercial producers. Most of the noncommercial output is paving gravel, largely unprepared material for use on low-cost, secondary roads. The growth in noncommercial production has been as spectacular as that of the industry itself; in 1923 it represented 1.5 percent of the entire tonnage of sand and gravel; in 1930 the proportion reached 10.2 percent; in 1935 it was 31.7 percent; and in 1940 it stood at 44.9 percent.

Figure 1 shows the growth of the sand and gravel industry since 1906 in both volume and value and by principal uses. During recent years the values of sand and gravel have approached each other more closely than have their tonnages. This is explained by the fact that industrial sand, the largest component of the classification "other sands," has a relatively high unit value, whereas paving gravel has a comparatively low value per ton. The ever-increasing demand for paving sand and gravel is shown clearly on this chart, which includes both commercial and noncommercial production. The proportion of sand for other than building and paving uses has remained fairly stable over the past 20 years, reflecting the noncompetitive nature of industrial sands. The decline in the proportion of railroad ballast to total gravel since 1930 may be explained by the curtailment of expenditures by the railroads for improvement and maintenance of road beds and structures during the depression years.

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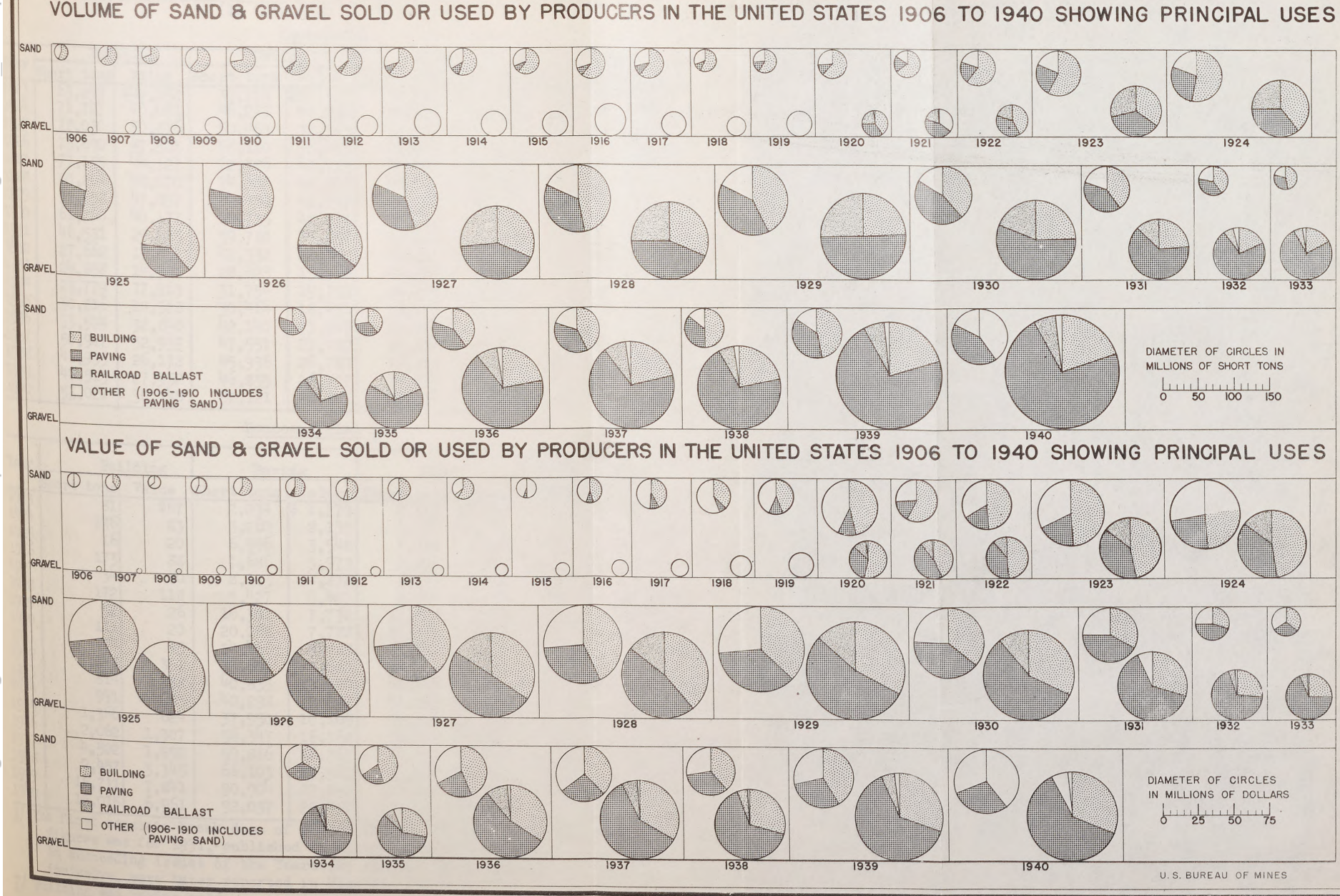
VOLUME OF SAND & GRAVEL SOLD OR USED BY PRODUCERS IN THE UNITED STATES 1906 TO 1940 SHOWING PRINCIPAL USES
SAND
GRAVEL
1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924
1925 1926 1927 1928 1929 1930 1931 1932 1933
1934 1935 1936 1937 1938 1939 1940
BUILDING
PAVING
RAILROAD BALLAST
OTHER (1906-1910 INCLUDES PAVING SAND)
DIAMETER OF CIRCLES IN MILLIONS OF SHORT TONS
0 50 100 150
VALUE OF SAND & GRAVEL SOLD OR USED BY PRODUCERS IN THE UNITED STATES 1906 TO 1940 SHOWING PRINCIPAL USES
DIAMETER OF CIRCLES IN MILLIONS OF DOLLARS
0 25 50 75
U. S. BUREAU OF MINES

Figure 1.—Growth of sand and gravel industry in volume and value of product since 1906, by principal uses.

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TABLE 1. - Commercial and noncommercial production of sand and gravel, 1923-40[1]/
(In thousands of short tons)

Commercial

Year	Building		Paving		Other		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1923	63,299	$42,052	39,773	$25,625	34,745	$21,880	137,817	$89,557
1924	71,727	46,091	46,278	28,230	34,829	20,470	152,834	94,791
1925	78,030	50,876	50,455	31,523	36,504	21,575	164,989	103,974
1926	75,690	47,505	58,110	36,443	41,442	23,330	175,242	107,278
1927	71,135	44,127	72,386	42,785	45,786	23,728	189,307	110,640
1928	80,204	48,070	74,907	42,507	44,409	23,016	199,520	113,593
1929	73,558	47,097	84,530	52,097	48,131	25,886	206,219	125,080
1930	61,760	40,177	80,715	48,237	34,405	18,955	176,880	107,369
1931	46,531	29,065	59,710	34,557	22,698	12,850	128,939	76,472
1932	27,662	17,057	42,332	22,352	15,295	8,080	85,289	47,489
1933	24,958	14,581	28,623	15,948	12,525	8,866	66,106	39,395
1934	28,779	17,963	31,754	19,751	14,791	10,651	75,324	48,365
1935	30,816	18,528	30,464	18,431	23,328	14,285	84,608	51,244
1936	53,574	32,840	42,140	23,947	24,207	15,445	119,921	72,232
1937	50,927	32,939	47,551	27,480	26,864	18,695	125,342	79,114
1938	41,955	26,172	45,936	26,780	17,869	12,064	105,760	65,016
1939	47,513	27,952	46,855	26,997	24,025	16,233	118,393	71,182
1940	53,021	30,448	51,121	28,809	27,114	19,013	131,256	78,270

Noncommercial 2/

Year	Building		Paving		Total		Grand total, commercial and noncommercial	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1923	81	$67	2,034	$ 1,279	2,115	$1,346	139,932	$90,903
1924	136	83	3,260	2,139	3,396	2,222	156,230	97,013
1925	16	20	6,996	3,548	7,012	3,568	172,001	107,542
1926	173	88	7,686	3,973	7,859	4,061	183,101	111,339
1927	34	20	8,113	4,870	8,147	4,890	197,454	115,530
1928	172	118	9,427	5,497	9,599	5,615	209,119	119,208
1929	52	26	16,301	7,730	16,353	7,756	222,572	132,836
1930	111	20	20,061	7,788	20,172	7,808	197,052	115,177
1931	74	45	24,466	9,763	24,540	9,808	153,479	86,280
1932	1,148	351	33,601	9,682	34,749	10,033	120,038	57,522
1933	814	338	40,835	13,340	41,649	13,678	107,755	53,073
1934	991	655	40,298	12,227	41,289	12,882	116,613	61,247
1935	1,366	624	37,950	10,109	39,316	10,733	123,924	61,977
1936	2,062	1,307	56,347	16,768	58,409	18,075	178,330	90,307
1937	4,502	1,992	59,816	16,367	64,318	18,359	189,660	97,473
1938	9,457	3,345	66,103	17,562	75,560	20,907	181,320	85,923
1939	16,711	7,841	90,904	27,042	107,615	34,883	226,008	106,065
1940	15,015	6,961	92,037	25,457	107,052	32,418	238,308	110,688

1/ The first separate break-down of commercial and noncommercial sand and gravel figures was for 1931, published in Minerals Yearbook 1932-33 and continued in succeeding issues of the Yearbook; similar data, covering 1923-30, inclusive, were later reported in Minerals Yearbook 1939.

2/ Building and paving only.

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GENERAL FEATURES OF THE INDUSTRY

Sand and gravel are found in nearly all sections of the United States, although the number of commercially workable deposits is limited by the nearness to consuming markets, mode of occurrence, and quality of the material. They are produced primarily for use in construction in the form of road metal, railroad ballast, building sand and concrete aggregate, the latter two being employed in concrete, mortar, plaster, stucco, and various kinds of bituminous mixtures. Industry consumes large quantities of molding sand, glass sand, engine sand, and other special sands. Inasmuch as transportation costs comprise a large percentage of the cost to the user, those pits near the consuming centers have a distinct advantage.

Sand and gravel deposits occur on land in pits and banks or under water in pits, streams, lakes, and oceans. The method of operation is governed largely by the type of occurrence, the amount of overburden of the land deposits, and the depth of the water deposits. Underwater deposits generally are exploited by means of pumps, buckets, ladder dredges, draglines, and cableway scrapers. Power shovels, draglines, scrapers, and occasionally hydraulic methods are employed to mine deposits above water.

The capital investment of a sand and gravel plant, in addition to the cost of land and equipment may range from a small outlay for the simple framework that supports one or two screens to large investments in plants containing a complicated arrangement of washers, scrubbers, screens, crushers, classifiers, and bins. For river and lake deposits either floating or land plants are used, depending on circumstances.

Sand and gravel used in construction must meet specifications of strength soundness, purity, sizing, and grading. These specifications and the rigidity of adherence to them vary in different localities; consequently, sand and gravel suitable for use in one locality may be rejected in another. Specifications of industrial sands differ with use. Glass sand must be almost pure silica, and the amount of such impurities as iron and aluminum permitted is strictly limited. Foundry sands must withstand high temperatures; and, moreover, proper grading is exceedingly important.

TRANSPORTATION PROBLEMS

A large factor in the ultimate cost of sand and gravel is transportation. In 1940 the over-all charge per ton of sand and gravel moved on class I railways was 79 cents, whereas the average price received per ton by commercial producers that year was 60 cents. As the limits of our large cities have been extended and rural areas developed, hauling distances, and consequently freight costs, have increased, with the result that numerous portable sand and gravel plants have been set up closer to the construction sites. In many places these plants compete successfully with large established plants because of the saving in transportation costs. Their growth has been a serious threat to producers with large investments in well-established plants, and some of these have sought to supplement their permanent operations with portable or semiportable plants. At least five companies are manufacturing portable-plant machinery, which includes excavating, pumping, crushing, screening, washing, and loading units mounted on trucks.

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Table 2 gives the quantities of sand and gravel shipped by commercial producers via truck, rail, and waterway from 1933 to 1940. It is evident that trucks are being used more and more at the expense of the railroad. This is explained in part by the increase in number of portable plants and in part by lower trucking rates and extension and improvement of highways. Shipping by truck for short distances often saves time because it obviates the necessity of reloading from train to truck to reach the construction site. Almost the entire output of Government operations is moved by truck. Of the total sand and gravel shipments made in 1940, including Government-and-contractor production, trucks moved 72 percent, rail 20 percent, and waterways 8 percent.

LABOR REQUIREMENTS

In 1940 the average number of men employed in 77 percent of the commercial sand and gravel industry reached 16,595, and each man produced an average of 3.3 short tons per hour, an increase of 0.3 ton per hour since 1934, the first year for which these data are reported. It is unfortunate that no data were compiled before that time, for the growth in number of men employed and output per man undoubtedly has been rapid. Technologic advances in the design of mechanical equipment and increasing use of such equipment are in large part responsible for this increase in output per man. In general the output per man is lower in noncommercial than in commercial production because mechanized equipment is used less extensively. Table 3 shows employment and production in the commercial sand and gravel industry each year from 1934 to 1940.

In a study of labor requirements in the sand and gravel industry conducted by the Department of Labor,3/ it was found that production of 100 short tons of sand and gravel required 31.0 man-hours of production labor (all types of operation), 1.6 man-hours for fuel and power supply, and 61.9 man-hours for haulage to the construction site. Upon the basis of the total of 94.5 man-hours required to produce and distribute 100 short tons of sand and gravel, the 238,308,000 short tons produced in 1940 indicate 225,201,060 man-hours of labor. Dividing this by 8.4, the average time employed per man per day, production in 1940 would have required 26,809,650 man-days of employment. The average number of days worked by each employee in 1940 was 217, which would indicate almost 125,000 men directly dependent on the sand and gravel industry for their livelihood.

3/ Ball, John A., Labor Requirements in Production and Distribution of Sand and Gravel: Bureau of Labor Statistics, Monthly Labor Review, July 1939.

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TABLE 2. - Sand and gravel sold or used by commercial producers in the United States, 1933-40, by methods of transportation

	1933		1934		1935		1936	
	Short tons (,000)	Percentage of total reported	Short tons (,000)	Percentage of total reported	Short tons (,000)	Percentage of total reported	Short tons (,000)	Percentage of total reported
Shipped by:								
Truck.....	18,078	31.7	21,448	31.7	23,481	31.3	38,537	37.0
Rail.....	31,253	54.7	38,763	57.4	42,319	56.4	53,520	51.3
Waterway.....	7,773	13.6	7,359	10.9	9,273	12.3	12,233	11.7
Percent of total commercial production.....	86.4		89.7		88.7		87.0	

	1937		1938		1939		1940	
	Short tons (,000)	Percentage of total reported	Short tons (,000)	Percentage of total reported	Short tons (,000)	Percentage of total reported	Short tons (,000)	Percentage of total reported
Shipped by:								
Truck.....	42,829	39.3	39,143	43.0	48,040	45.2	54,063	45.8
Rail.....	51,613	47.4	37,675	41.3	42,118	39.6	45,255	38.4
Waterway.....	14,535	13.3	14,279	15.7	16,209	15.2	18,600	15.8
Percent of total commercial production.....	86.9		86.1		89.8		89.8	

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TABLE 3. - Employment in commercial sand and gravel industry, sand and gravel produced at plants included in the study, and average output per man in the United States, 1934-39 1/

Year	Employment 2/					Production			Percentage of commercial industry represented
	Average number of men	Time employed				Commercial sand and gravel, short tons	Average per man, short tons		
		Average number of days	Total man-shifts	Man-hours			Per shift	Per hour	
				Average per man per day	Total				
1934..	14,611	168	2,452,835	8.1	19,897,633	59,018,238	24.1	3.0	78.4
1935..	11,926	197	2,351,453	8.3	19,578,368	60,826,691	25.9	3.1	75.4
1936..	16,127	207	3,332,532	8.6	28,672,615	95,219,468	28.6	3.3	83.8
1937..	16,062	215	3,458,994	8.6	29,754,746	97,113,001	28.1	3.3	81.8
1938..	14,971	201	3,001,796	8.5	25,578,807	81,742,896	27.2	3.2	81.1
1939..	15,617	214	3,335,321	8.4	28,054,960	96,755,364	29.0	3.5	81.7
1940..	16,595	217	3,596,886	8.4	30,263,744	101,143,305	28.1	3.3	77.1

1/ Does not include plants operated by or directly for States, counties, municipalities, and other Government agencies.

2/ Does not include employers or salaried employees.

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NUMBER AND SIZE OF PLANTS

A special study of the changes in number and size of plants reveals some unusual trends. Where industry in general has been consolidating into fewer and larger units the sand and gravel industry has been decentralizing thus increasing the proportion of smaller to larger plants since 1930. Figure 2 and table 4 present a summary of the changes in the industry in 5-year periods since 1910 and each year since 1935. In 1910 plants producing less than 25,000 short tons of sand and gravel a year comprised 78 percent of all plants, whereas they supplied 16 percent of the output. In 1925 these percentages were 54 and 5, respectively. By 1940 firms in this group represented 55 percent of the total number and produced 8 percent of the total tonnage. Plants reporting over 100,000 short tons a year constituted 6 percent of all plants in 1910 and produced 57 percent of all sand and gravel. These firms comprised 19 percent of the plants and 76 percent of the production in 1925. By 1940, however, their relative importance had fallen to 15 percent of all plants and 64 percent of all production.

It must be remembered that a drop or rise in the proportion of plants in any one classification does not mean that firms of that size started or stopped operations, but rather that changes in output threw many plants into different size groups as their output increased or declined. The trends of production of five companies in business since 1910 are shown in figure 3. Companies A and B have been reported in four of the size groups. Between 1938 and 1940 company C moved from the 25,000- to 50,000-ton group to the 75,000- to 100,000-ton group and back to the 50,000- to 75,000-ton class. Company D reached the 50,000- to 75,000-ton class in 1925 and 1936 but fluctuated between the two lower groups in the other years. Company E has been included in the 1,000- to 25,000-ton class every year since 1915.

The major factor in the tendency toward decentralization during the past 15 years has been the development of the portable plant. As stated earlier in this report, a small producer with his portable equipment may compete successfully with larger established operators because of the saving in transportation costs and the relative ease with which operations may be set up or moved from one locality to another.

The growth in proportion of production contributed by plants producing less than 25,000 short tons during the past 15 years as compared with the relative stability in number of these plants may be explained by the decline in the proportion of plants producing less than 1,000 short tons a year.

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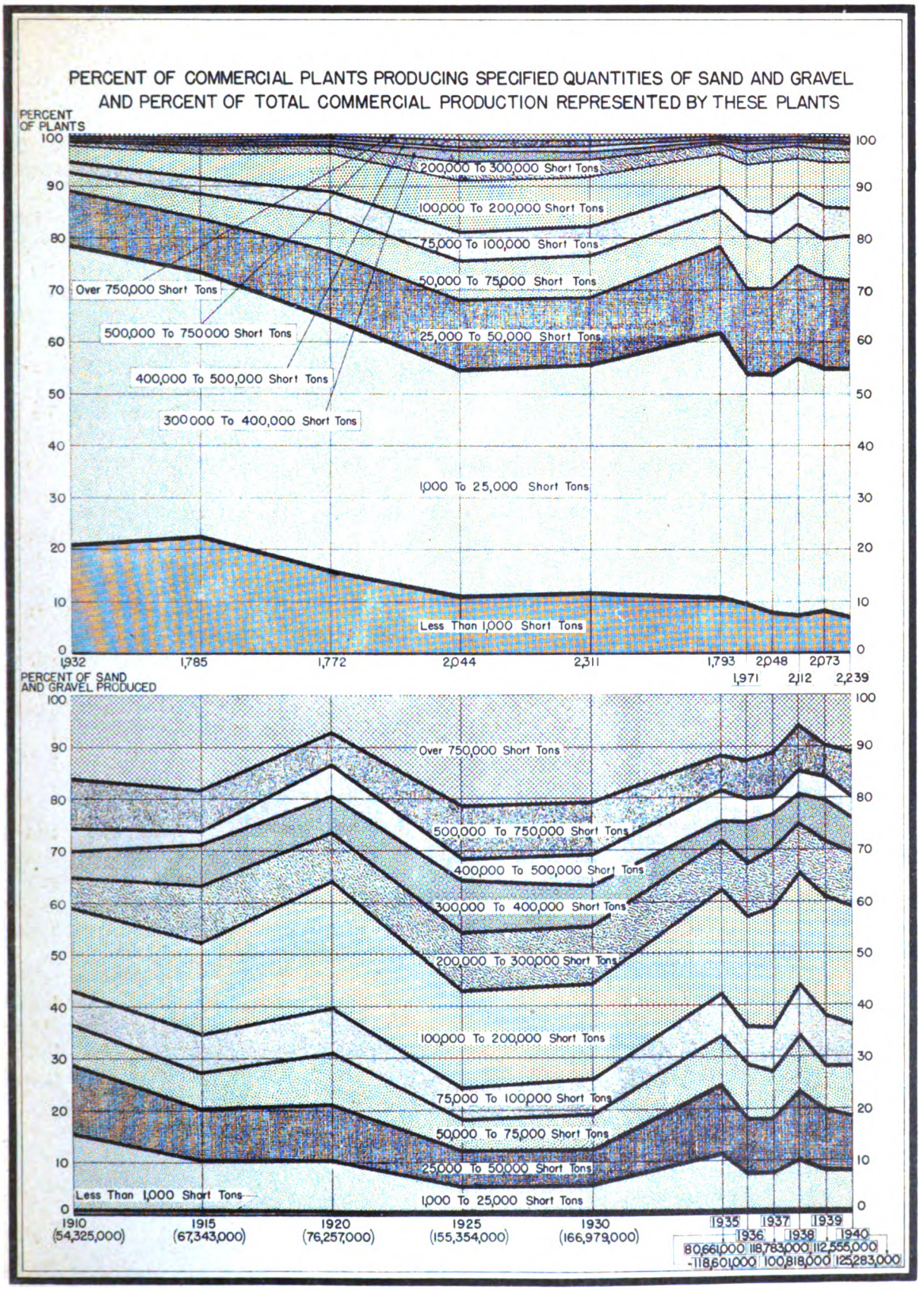

Figure 2.--Summary of changes in sand and gravel industry in 5-year periods since 1910 and in each year since 1935.

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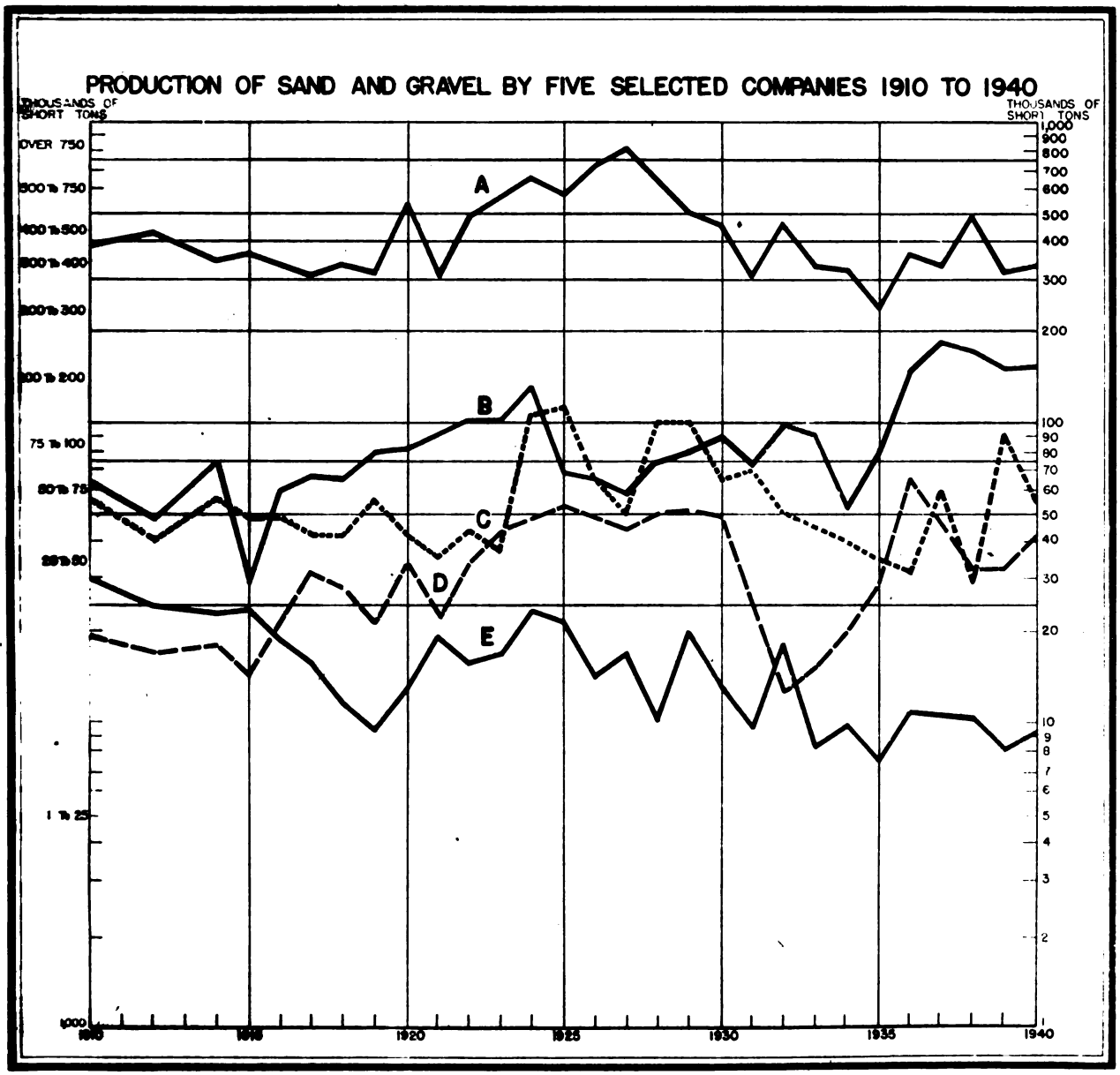

Figure 3.—Trend of production of five sand and gravel companies in business since 1910.

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TABLE 4. - Production of sand and gravel and number of companies in different ranges of output for selected years

Thousands of short tons per year	1910		1915		1920		1925	
	No. of cos.	Production	No. of cos.	Production	No. of cos.	Production	No. of cos.	Production
Under 1.....	403	161,503	399	160,074	279	115,283	220	119,482
1-25.....	1,111	8,330,479	910	6,925,428	860	7,791,109	887	7,990,853
25-50.....	201	7,163,944	184	6,568,468	228	8,110,784	278	10,295,678
50-75.....	69	4,174,448	80	4,766,685	125	7,651,942	159	9,643,779
75-100.....	41	3,573,908	57	4,942,925	79	6,737,664	110	9,497,422
100-200.....	63	8,563,389	85	11,869,082	137	18,632,119	208	28,981,513
200-300.....	14	3,342,272	30	7,397,134	27	7,187,696	71	17,280,489
300-400.....	8	2,716,887	16	5,328,310	15	5,315,940	45	15,739,721
400-500.....	5	2,255,948	4	1,708,142	10	4,503,199	14	6,290,201
500-750.....	9	5,145,683	9	5,299,078	8	4,741,730	26	15,617,071
Over 750.....	8	8,896,409	11	12,377,740	4	5,470,028	26	33,286,763
Total.....	1,932	54,324,570	1,785	67,343,066	1,772	76,257,494	2,044	154,742,972
Railroads....		13,128,972		9,581,236		5,259,841		10,156,933
Noncommercial		55,512		61,512		524,053		7,011,599
Total-all sand and gravel.....		1/69,410,436		76,985,814		82,041,388		171,911,504

(See footnote on page 11)

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TABLE 4. - Production of sand and gravel and number of companies in different ranges of output for selected years (Cont'd.)

Thousands of short tons per year	1930		1935		1936		1937	
	No. of cos.	Production	No. of cos.	Production	No. of cos.	Production	No. of cos.	Production
Under 1.....	263	109,914	190	83,375	186	83,216	158	70,243
1-25.....	1,013	8,976,701	913	9,039,951	873	8,258,669	935	8,934,888
25-50.....	304	10,953,139	297	10,584,101	329	11,872,494	342	12,411,553
50-75.....	186	11,424,275	130	7,805,228	197	11,873,872	178	10,691,233
75-100.....	129	11,196,463	77	6,570,699	94	8,254,952	119	10,213,081
100-200.....	224	31,048,826	122	16,481,643	180	24,302,580	205	27,744,988
200-300.....	77	18,481,140	30	7,312,124	49	11,685,467	54	13,040,167
300-400.....	38	13,075,953	9	3,031,939	27	9,214,938	23	8,068,179
400-500.....	23	10,107,620	11	4,823,006	11	4,880,413	9	4,043,019
500-750.....	27	17,010,826	9	5,384,908	14	8,464,083	16	9,988,275
Over 750.....	27	34,593,933	5	9,544,459	11	14,710,494	9	13,577,777
Total.....	2,311	166,978,790	1,793	80,661,433	1,971	113,601,178	2,048	118,783,403
Railroads.....		9,901,316		3,946,038		6,319,217		6,559,075
Noncommercial		20,171,620		39,316,452		58,409,419		64,317,945
Total-all sand and gravel.....		197,051,726		123,923,923		178,329,814		189,660,423

(See footnote on page 11)

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TABLE 4. - Production of sand and gravel and number of companies in different ranges of output for selected years (Cont'd.)

Thousands of short tons per year	1938		1939		1940	
	No. of cos.	Production	No. of cos.	Production	No. of cos.	Production
Under 1.....	155	76,747	167	90,989	155	66,113
1-25.....	1,040	10,212,529	966	9,328,661	1,069	10,151,813
25-50.....	380	13,419,262	363	12,934,372	379	13,538,298
50-75.....	173	10,645,610	156	9,605,852	194	11,903,681
75-100.....	117	10,035,033	126	10,882,635	116	9,997,509
100-200.....	161	22,147,182	186	25,686,504	204	28,524,529
200-300.....	39	9,349,235	50	12,077,434	54	12,980,624
300-400.....	17	5,774,130	26	9,085,604	25	8,546,153
400-500.....	10	4,405,964	11	4,948,027	11	4,943,264
500-750.....	15	8,672,631	12	6,960,521	19	10,900,068
Over 750.....	6	6,079,983	10	10,954,661	13	13,731,015
Total.....	2,113	100,818,306	2,073	112,555,260	2,239	125,283,067
Railroads....		4,941,480		5,837,860		5,973,200
Noncommercial		75,560,447		107,615,000		107,052,000
Total-all sand and gravel.....		181,320,233		226,008,000		238,308,000

1/ Includes 1,901,382 short tons of chats.

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The decline in the relative importance of those plants producing more than 750,000 short tons of sand and gravel a year may be appreciated more readily if it is noted that in 1910 eight such plants produced 16 percent of all of that year's tonnage; in 1915, 11 plants produced 18 percent; in 1920, 4 plants produced 7 percent; in 1925, 26 plants accounted for 22 percent; and in 1930, 27 plants contributed 21 percent. The era of large plants reached its culmination in the period from 1925 to 1930. Thereafter both the number of large plants and their share of the total United States output declined greatly, as indicated by the following comparative figures: 1935, 5 plants, 12 percent; 1936, 11 plants, 13 percent; 1937, 9 plants, 11 percent; 1938, 6 plants, 6 percent; 1939, 10 plants, 10 percent; 1940, 13 plants, 11 percent.

MULTIPLE-PLANT COMPANIES

In this discussion the term "plant" is applied to each separate operation, whether worked as an individual enterprise or grouped with one or more other operations under single ownership (multiple-plant company). A study of multiple-plant companies in 1940 reveals that 168 companies owned two or more plants. There were 107 companies owning two plants, 25 companies owning 3 plants, 17 companies with 4 plants, 8 companies with 5 plants, 4 companies with 6 plants, and 7 companies with 6 to 16, owning a total of 81 plants. Table 5 presents the number of plants and the number of companies in each size group and their production. As the number of multi-plant companies is small compared with the number of single-plant companies, the relative proportion of the output contributed by companies in each size group differs little from the proportions contributed by single plants. An exception to this is the largest group, in which the combined production of plants owned by large companies placed 12 additional companies. Where 0.6 percent of all plants produced 10.9 percent of all output, 1.3 percent of all companies produced 24.3 percent of all output.

TABLE 5. - Number and production of commercial sand and gravel plants and companies, by sizes of output, 1940

	No. of plants	Total production of plants (short tons)	No. of companies	Total production of companies (short tons)
Less than 1,000.....	155	66,113	141	60,539
1,000 to 25,000.....	1,069	10,151,813	905	8,247,471
25,000 to 50,000.....	379	13,538,298	317	11,265,365
50,000 to 75,000.....	194	11,903,681	153	9,393,090
75,000 to 100,000....	116	9,997,509	95	8,191,371
100,000 to 200,000...	204	28,524,529	176	24,627,396
200,000 to 300,000...	54	12,980,624	40	9,962,333
300,000 to 400,000...	25	8,546,153	27	9,201,135
400,000 to 500,000...	11	4,943,264	11	4,924,275
500,000 to 750,000...	19	10,900,068	15	8,902,231
750,000 and over.....	13	13,731,015	25	30,507,861
Total.....	2,239	125,283,067	1,905	125,283,067

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PRODUCTION BY STATES

In 1940 New York, California, and Illinois, led all States in commercial production of sand and gravel (excluding railroads), each producing more than 10 million short tons. New York, with 202 plants, produced more than 13,200,000 tons, or 10.5 percent of the Nation's commercial output. The 151 plants in California reported production of 12,750,000 tons, slightly more than 10 percent of the total; and Illinois, with 145 plants, accounted for 10,100,000 short tons. Ohio had 198 plants, which produced more than 9,000,000 tons; Michigan and Pennsylvania each produced 8,400,000 tons, Michigan having 105 plants and Pennsylvania 122. Indiana had 112 plants, which produced more than 5,750,000 tons. These 7 States accounted for 54 percent of all the sand and gravel produced by commercial plants in 1940 but had within their borders only 46 percent of the Nation's plants.

Table 6 shows the number and average production of plants by States at 10-year intervals since 1910. Although the size groups have been combined into three classes, it was necessary to conceal many of the totals of States with few plants. The size of each State's contribution to the national total has changed markedly, as have the number and size of plants within each State.

In 1910 Pennsylvania led the country with 244 plants, while Ohio was a close second with 231. The production of the seven leading States mentioned above was 56 percent of the Nation's total, and their plants constituted 47 percent. However, California had only 38 plants that year and produced slightly more than 1,000,000 tons. Iowa and New Jersey each had over 100 plants, Iowa producing 1,300,000 tons and New Jersey 2,900,000 tons. Iowa, New York, Ohio, and Pennsylvania each had more than 100 plants in the under-25,000-ton group, and all of these States except Iowa had a State average production greater than the national average of that class.

By 1920 the picture had changed considerably, and Michigan led in number of plants with 171, followed closely by Pennsylvania, 169; Illinois, 160; and Ohio, 159. The seven States leading in the 1940 reports accounted for 52 percent of both production and plants in 1920. In the class under 25,000 tons, Michigan had 131 plants, Pennsylvania 122, and Illinois 103, and in all of these States the average production per plant dropped below the national average for plants of this size.

1930 was the most prosperous of the 4 years under comparison, with nearly four times as many plants in the group producing more than 100,000 tons as in 1910 and more than twice as many as in 1920. In this year New York had 234 plants with an average production of nearly 88,000 tons per plant. Illinois, with 196, had almost the same average annual production, while Ohio's 160 plants maintained an average of 77,000 tons. The seven leading States were the same as in 1940 and accounted for 54 percent of production and 48 percent of plants. New York and Illinois had 20 percent of the Nation's smaller plants, 16 percent of the medium-size plants, and 17 percent of the larger plants.

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TABLE 6. - Number and average production of commercial sand and gravel plants by States and size of plants, 1910-40

State	1910							
	Under 25,000		25,000-100,000		100,000 and over		Total	
	No. of Plants	Average production	No. of plants	Average production	No. of plants	Average production	No. of plants	Average production
Alabama	15	6,376	6	38,489	2	139,605	23	26,338
Arizona	3	12,432	-	-	-	-	3	12,432
Arkansas	24	6,281	7	62,578	-	-	31	18,994
California	26	7,247	9	50,146	3	147,833	38	28,506
Colorado	12	5,984	-	-	1	1/	13	1/
Connecticut	10	1,668	-	-	-	-	10	1,668
Delaware	4	663	-	-	1	1/	5	1/
District of Columbia	-	-	-	-	-	-	-	-
Florida	7	4,980	-	-	-	-	7	4,980
Georgia	29	6,216	4	37,170	-	-	33	9,968
Hawaii	1	1/	-	-	-	-	1	1/
Idaho	2	2,838	1	1/	-	-	3	10,892
Illinois	87	5,396	18	55,705	13	240,308	118	38,951
Indiana	95	5,585	29	54,245	8	400,038	132	40,182
Iowa	123	4,894	13	39,181	1	1/	137	1/
Kansas	5	9,959	9	47,844	2	119,875	16	45,009
Kentucky	29	6,667	4	38,267	1	1/	34	1/
Louisiana	4	9,251	3	29,329	2	1/	9	1/
Maine	2	7,285	1	1/	-	-	3	13,856
Maryland	17	4,443	3	40,653	3	252,300	23	41,495
Massachusetts	24	5,718	4	46,155	-	-	28	11,495
Michigan	55	5,874	14	47,658	7	199,092	76	31,367
Minnesota	27	3,588	9	42,760	-	-	36	13,381
Mississippi	16	5,195	3	32,067	1	1/	20	1/
Missouri	41	4,513	7	49,256	8	410,606	56	68,119
Montana	1	1/	-	-	-	-	1	1/
Nebraska	14	5,250	6	69,701	4	127-798	24	41,787
Nevada	-	-	-	-	-	-	-	-
New Hampshire	-	-	-	-	-	-	-	-
New Jersey	94	5,987	13	64,520	7	220,398	114	25,827

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Table 6. - Number and average production of commercial sand and gravel plants by States and size of plants, 1910-40 (Con'td.)

State	1910							
	Under 25,000		25,000-100,000		100,000 and over		Total	
	No. of plants	Average production	No. of plants	Average production	No. of plants	Average production	No. of plants	Average production
New Mexico	3	1,437	-	-	-	-	3	1,437
New York	112	5,740	14	50,513	13	438,879	139	50,759
North Carolina.....	9	1,828	-	-	-	-	9	1,828
North Dakota.....	4	3,972	-	-	-	-	4	3,972
Ohio	178	5,678	43	43,319	10	157,422	231	19,253
Oklahoma.....	13	5,913	8	57,147	-	-	21	25,431
Oregon.....	6	13,435	2	28,753	4	313,313	12	115,947
Pennsylvania	202	5,679	35	48,023	7	406,753	244	23,259
Rhode Island.....	-	-	-	-	-	-	-	-
South Carolina	3	227	-	-	1	1/	4	1/
South Dakota.....	6	5,087	1	1/	-	-	7	1/
Tennessee	35	7,776	4	32,771	1	1/	40	1/
Texas.....	25	8,366	13	40,759	1	1/	39	1/
Utah	2	1/	-	-	-	-	2	1/
Vermont	5	1,284	1	1/	-	-	6	1/
Virginia.....	28	4,552	3	42,632	-	-	31	8,237
Washington	3	10,052	8	49,709	4	286,865	15	105,019
West Virginia	33	8,209	9	36,539	1	1/	43	1/
Wisconsin	80	4,091	7	57,116	1	1/	88	1/
Wyoming.....	-	-	-	-	-	-	-	-
TOTAL-United States..	1,514	5,609	311	47,950	107	288,975	1,932	28,118

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TABLE 6. - Number and average production of commercial sand and gravel plants by States and size of plants, 1910-40 (Cont'd.)

State	1920							
	Under 25,000		25,000-100,000		100,000 and over		Total	
	No. of plants	Average production	No. of plants	Average production	No. of plants	Average production	No. of plants	Average production
Alabama	8	10,250	6	53,311	2	230,409	16	53,918
Arizona	2	1/	-	-	-	-	2	1/
Arkansas	6	9,303	6	62,912	2	153,649	14	52,899
California	24	9,391	19	58,625	9	297,555	52	77,255
Colorado	8	7,193	1	1/	1	1/	10	1/
Connecticut	10	8,375	7	36,803	-	-	17	20,081
Delaware	3	10,440	-	-	-	-	3	10,440
District of Columbia	-	-	-	-	1	1/	1	1/
Florida	2	5,446	3	40,619	-	-	5	26,550
Georgia	18	10,739	3	60,584	-	-	21	17,860
Hawaii	1	1/	1	1/	-	-	2	1/
Idaho	2	1/	-	-	-	-	2	1/
Illinois	103	5,860	36	57,053	21	203,225	160	43,283
Indiana	55	7,580	36	55,039	13	209,170	104	49,207
Iowa	74	7,553	19	45,667	6	142,386	99	23,040
Kansas	8	13,499	6	70,975	4	185,366	18	70,851
Kentucky	14	8,499	2	33,300	4	271,823	20	63,644
Louisiana	3	10,029	3	59,746	6	143,857	12	89,372
Maine	4	1,792	2	34,604	-	-	6	12,749
Maryland	14	7,529	6	43,965	2	587,302	22	70,172
Massachusetts	28	6,628	6	49,049	4	184,484	38	32,047
Michigan	131	3,607	29	51,809	11	203,217	171	24,622
Minnesota	25	8,594	10	58,595	4	196,065	39	40,642
Mississippi	1	1/	8	49,928	6	227,870	15	118,065
Missouri	24	6,014	12	55,791	4	234,210	40	43,766
Montana	5	9,157	1	1/	-	-	6	1/
Nebraska	21	6,328	8	56,933	2	531,156	31	53,247
Nevada	-	-	-	-	-	-	-	-
New Hampshire	3	11,499	-	-	1	1/	4	1/
New Jersey	40	7,310	16	48,467	13	272,890	69	66,890

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TABLE 6. - Number and average production of commercial sand and gravel plants by States and size of plants, 1910-40 (Cont'd.)

State	1920							
	Under 25,000		25,000-100,000		100,000 and over		Total	
	No. of plants	Average production	No. of plants	Average production	No. of plants	Average production	No. of plants	Average production
New Mexico	-	-	1	1/	-	-	1	1/
New York	80	7,932	19	50,015	11	406,974	110	55,105
North Carolina	8	8,209	1	1/	2	168,424	11	1/
North Dakota	2	1/	-	-	-	-	2	1/
Ohio	96	8,151	43	46,385	20	190,682	159	41,451
Oklahoma	14	11,807	3	58,451	3	127,911	20	36,219
Oregon	6	10,359	10	47,329	3	165,006	19	54,235
Pennsylvania	122	6,794	31	47,933	16	253,463	169	37,693
Rhode Island	4	4,495	-	-	-	-	4	4,495
South Carolina	7	10,667	2	33,097	1	1/	10	1/
South Dakota	11	8,086	1	1/	-	-	12	1/
Tennessee	16	5,946	10	57,004	2	226,032	28	39,902
Texas	17	10,129	11	58,120	9	226,422	37	77,008
Utah	4	8,169	2	55,939	2	141,272	8	53,387
Vermont	7	1,503	1	1/	-	-	8	1/
Virginia	19	4,463	4	64,617	5	158,348	28	40,536
Washington	7	11,391	11	50,446	4	235,391	22	71,805
West Virginia	13	8,027	14	56,829	5	129,572	32	48,369
Wisconsin	67	4,848	22	51,432	2	267,397	91	21,880
Wyoming	2	1/	-	-	-	-	2	1/
TOTAL - United States	1,139	6,942	432	52,084	201	228,113	1,772	43,035

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TABLE 6. - Number and average production of commercial sand and gravel plants by States and size of plants, 1910-40 (Cont'd.)

State	1930							
	Under 25,000		25,000-100,000		100,000 and over		Total	
	No. of plants	Average production	No. of plants	Average production	No. of plants	Average production	No. of plants	Average production
Alabama	5	7,393	5	46,385	3	302,104	13	90,400
Arizona	3	11,682	3	39,209	1	1/	7	1/
Arkansas	7	5,604	11	66,944	10	156,332	28	83,534
California	66	10,709	30	59,286	18	486,642	114	98,640
Colorado	9	8,669	3	37,513	2	259,417	14	36,385
Connecticut	21	7,914	10	48,407	-	-	31	20,976
Delaware	3	7,457	1	1/	-	-	4	1/
District of Columbia	-	-	-	-	2	1/	2	1/
Florida	9	12,085	7	55,348	-	-	16	31,012
Georgia	16	10,375	4	49,542	1	1/	21	1/
Hawaii	-	-	-	-	-	-	-	-
Idaho	12	3,683	1	1/	-	-	13	1/
Illinois	120	5,271	33	52,303	43	341,366	196	86,925
Indiana	65	7,358	41	50,322	27	248,558	133	69,568
Iowa	43	7,606	18	51,564	13	196,505	74	51,483
Kansas	28	5,695	19	53,968	11	164,928	58	51,708
Kentucky	12	3,788	5	59,710	7	236,299	24	83,254
Louisiana	6	9,806	8	54,201	9	314,058	23	144,303
Maine	14	2,943	2	40,889	1	1/	17	1/
Maryland	10	5,495	4	42,896	5	480,917	19	138,480
Massachusetts	29	7,447	21	53,021	5	259,067	55	47,722
Michigan	78	6,376	30	49,828	22	330,225	130	71,208
Minnesota	59	6,930	13	62,469	9	248,446	81	42,679
Mississippi	5	4,548	4	64,010	11	156,130	20	99,811
Missouri	15	9,526	18	54,252	15	292,772	48	114,812
Montana	7	4,793	3	35,610	2	164,264	12	39,076
Nebraska	29	6,912	12	47,741	10	252,824	51	64,737
Nevada	2	1/	-	-	-	-	2	1/
New Hampshire	5	3,269	-	-	2	1/	7	1/
New Jersey	56	6,460	37	50,202	15	250,017	108	55,273

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TABLE 6. - Number and average production of commercial sand and gravel plants by States and size of plants, 1910-40 (Cont'd.)

State	1930							
	Under 25,000		25,000-100,000		100,000 and over		Total	
	No. of plants	Average production	No. of plants	Average production	No. of plants	Average production	No. of plants	Average production
New Mexico.....	4	14,307	3	60,813	-	-	7	34,238
New York	137	7,233	69	52,273	28	570,429	234	87,909
North Carolina	8	7,059	6	60,625	2	190,000	16	50,014
North Dakota	14	5,969	1	1/	-	-	15	1/
Ohio	78	8,434	52	54,015	30	299,944	160	77,906
Oklahoma.....	11	11,290	13	54,945	9	189,248	33	77,022
Oregon	21	10,650	15	59,329	4	160,037	40	43,843
Pennsylvania.....	88	6,930	25	58,050	25	354,519	138	79,160
Rhode Island.....	12	5,976	1	1/	1	1/	14	17,322
South Carolina.....	2	8,363	4	74,619	3	143,059	9	82,709
South Dakota.....	14	5,057	2	58,461	1	1/	17	1/
Tennessee.....	12	5,205	8	56,912	7	232,885	27	79,554
Texas.....	33	7,211	26	69,074	21	281,595	80	99,342
Utah.....	1	1/	2	69,748	2	141,466	5	1/
Vermont.....	7	5,616	-	-	-	-	7	5,616
Virginia.....	17	3,208	5	48,804	6	187,562	28	50,854
Washington.....	29	9,960	10	50,664	5	465,554	44	70,983
West Virginia.....	5	14,036	9	48,548	11	198,939	25	107,817
Wisconsin.....	46	4,811	25	55,649	17	214,655	88	59,792
Wyoming	3	5,373	-	-	-	-	3	5,373
TOTAL- United States	1,276	7,121	619	54,239	416	298,842	2,311	72,254

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TABLE 6. - Number and average production of commercial sand and gravel plants by States and size of plants, 1910-40 (Cont'd.)

State	1940							
	Under 25,000		25,000-100,000		100,000 and over		Total	
	No. of plants	Average production	No. of plants	Average production	No. of plants	Average production	No. of plants	Average production
Alabama	7	9,433	7	54,553	5	244,361	19	87,879
Arizona	5	8,843	2	30,626	-	-	7	15,066
Arkansas	9	9,514	11	51,270	3	139,675	23	46,462
California	75	10,431	43	48,558	33	299,360	151	84,432
Colorado	16	7,900	3	53,836	1	1/	20	1/
Connecticut	17	10,343	13	42,259	2	197,465	32	35,004
Delaware	4	6,017	3	47,690	-	-	7	23,877
District of Columbia	-	-	-	-	-	-	-	-
Florida	7	14,920	6	52,948	3	239,184	16	71,230
Georgia	7	11,992	4	45,001	1	1/	12	1/
Hawaii	-	-	-	-	-	-	-	-
Idaho	16	5,780	6	50,302	-	-	22	17,923
Illinois	86	7,364	33	51,030	26	299,459	145	69,677
Indiana	60	7,247	31	47,810	21	183,140	112	51,454
Iowa	41	9,369	25	57,246	8	185,660	74	44,602
Kansas	27	10,124	25	54,893	1	1/	53	1/
Kentucky	7	3,215	6	49,361	4	194,212	17	64,442
Louisiana	9	7,161	5	51,391	8	246,139	22	104,114
Maine	19	4,313	1	1/	-	-	20	1/
Maryland	10	10,896	8	46,768	5	566,027	23	144,054
Massachusetts	43	7,697	32	51,108	5	199,230	80	37,033
Michigan	58	7,370	25	60,354	22	293,950	105	80,030
Minnesota	39	8,823	18	48,481	9	154,501	66	39,504
Mississippi	4	2,128	12	56,688	6	141,307	22	69,846
Missouri	20	10,085	20	52,389	8	255,370	48	68,592
Montana	15	9,014	7	42,993	2	112,880	24	27,580
Nebraska	35	9,523	17	51,246	7	140,325	59	37,064
Nevada	4	10,377	1	1/	1	1/	6	1/
New Hampshire	5	7,298	3	44,625	-	-	8	21,296
New Jersey	42	8,994	31	53,246	15	191,940	88	55,767

 (See footnote on p. 21)

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TABLE 6. - Number and average production of commercial sand and gravel plants by States and size of plants, 1910-40 (Cont'd.)

State	1940							
	Under 25,000		25,000-100,000		100,000 and over		Total	
	No. of plants	Average production	No. of plants	Average production	No. of plants	Average production	No. of plants	Average production
New Mexico	2	1/	1	1/	-	-	3	21,315
New York	125	7,349	56	50,752	21	450,430	202	65,444
North Carolina	6	9,337	4	60,122	5	208,988	15	89,430
North Dakota	9	6,539	4	46,191	-	-	13	18,740
Ohio	109	9,492	61	53,048	28	170,798	198	45,722
Oklahoma	14	12,450	6	52,837	-	-	20	24,566
Oregon	24	9,095	19	48,567	2	227,344	45	35,461
Pennsylvania	73	5,778	30	51,133	19	337,223	122	68,550
Rhode Island	8	10,287	3	67,281	-	-	11	25,831
South Carolina	4	10,590	6	58,891	-	-	10	39,570
South Dakota	12	6,845	1	1/	-	-	13	1/
Tennessee	11	6,059	10	49,383	7	191,663	28	67,933
Texas	21	8,194	21	49,510	19	161,074	61	70,036
Utah	12	10,785	7	68,657	3	149,124	22	48,063
Vermont	2	1/	1	1/	-	-	3	24,072
Virginia	8	8,877	9	48,181	6	242,657	23	85,243
Washington	35	7,532	12	45,821	5	178,023	52	32,762
West Virginia	12	12,738	10	56,369	7	154,027	29	61,887
Wisconsin	45	7,636	28	51,006	8	172,639	81	38,925
Wyoming	5	9,075	2	48,956	-	-	7	20,470
TOTAL-United States	1,224	8,348	689	51,436	326	244,250	2,239	55,955

1/ Concealed to avoid revealing data of individual companies.

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COMPETITION WITH CRUSHED STONE

For the major uses, namely, concrete aggregate, road stone, and railroad ballast, sand and gravel and crushed stone are generally interchangeable. Where both products are available near consuming centers, the one that can be produced most cheaply and yet meet specifications wins the market. Sand and gravel occur in nearly all parts of the United States. Stone also occurs widely, although each variety is generally limited to specific areas.

Figure 4 shows the location of all pits reported to the Bureau of Mines as producing sand and/or gravel used in any kind of construction in 1940. Each dot represents an active pit, regardless of the volume of material produced. Inasmuch as 1940 was a fairly active year as regards construction and new pits can be opened without difficulty, the map may be regarded as a reasonably accurate index of the commercial sources of supply of sand and gravel.

The locations of quarries producing crushed stone used in construction in 1940 appear in figure 5. The solid circles show where limestone was crushed for use as concrete, road metal, railroad ballast, or other construction uses, whereas the open circles represent all other kinds of stone crushed for these purposes.

Sand and gravel pits are more widely dispersed and more numerous than stone quarries because their operation requires less equipment, and new pits can be opened easily if a new demand arises in regions where sand and gravel deposits are available. Sand and gravel pits are abundant in the glacial deposits of the northeastern quarter of the United States; but beyond the Ohio and Missouri Rivers, which mark the southern limits of the terminal moraine, they are scattered more sparingly. The Pacific coastal plain supplies material for many sand and gravel deposits. River beds and their banks furnish much sand and gravel, and the concentration of pits along the Mississippi and Ohio Rivers is noteworthy. The Arkansas, Missouri, and Willamette Rivers are not shown on the map, although their courses may be traced by the locations of the pits that follow their channels.

Crushed stone also is often produced near rivers, partly because of cheap water transportation but also because shelf quarries can be opened conveniently in river bluffs. The Appalachian Mountain range is clearly outlined by the stone quarries shown on the map. Crushed stone, like sand and gravel, is produced most abundantly around the industrial areas of the East, Middle West, and Far West.

In only a few places are both crushed stone and sand and gravel produced in the same immediate neighborhood. Notable among these are the Los Angeles and San Francisco areas, parts of Illinois, southeastern Pennsylvania, central New York, Connecticut, and Massachusetts. In general each has its own local market area, but low-cost transportation may result in keen competition in certain areas.

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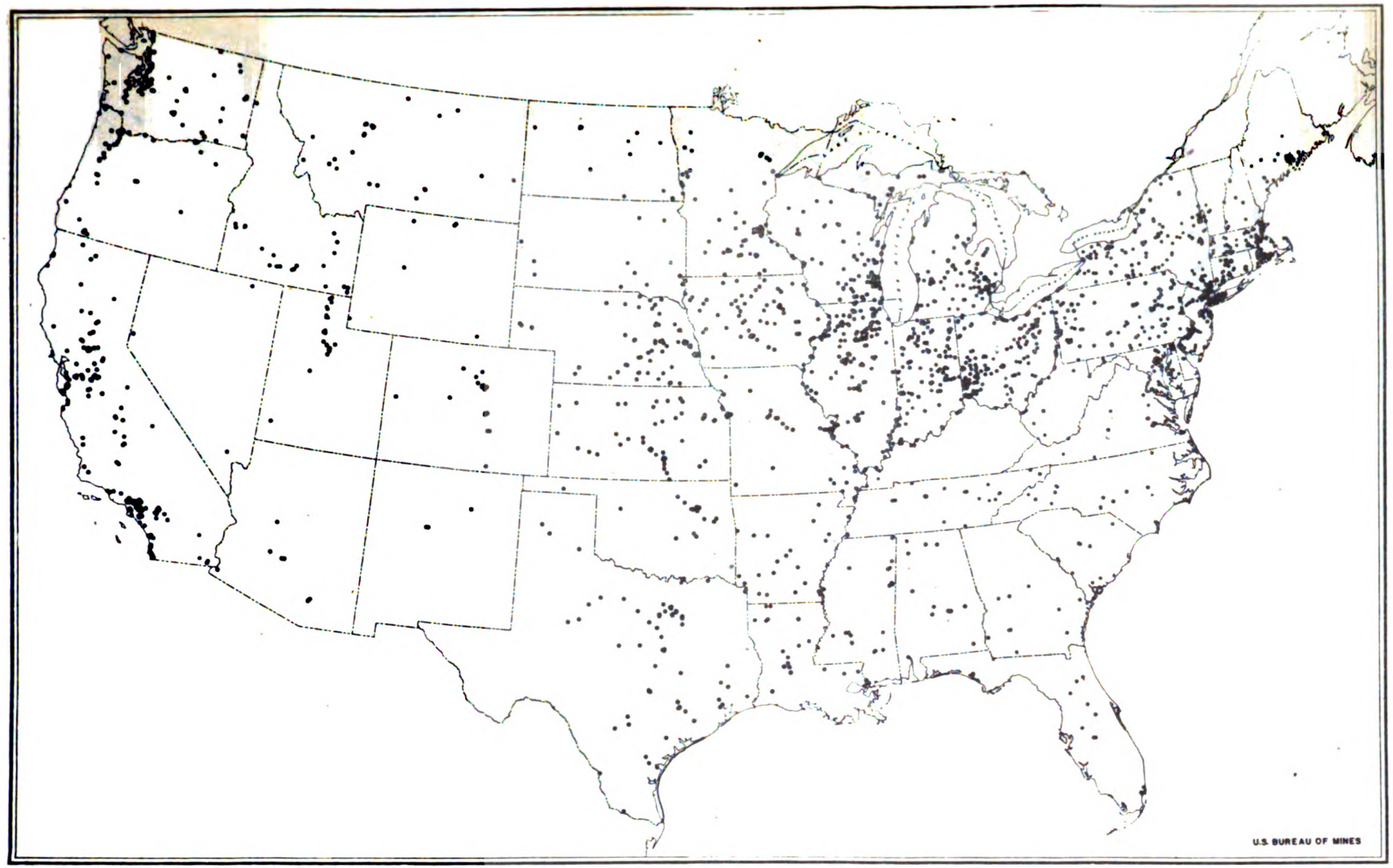

Figure 4.—Location of commercial sand and gravel pits reporting production for building purposes in 1940.

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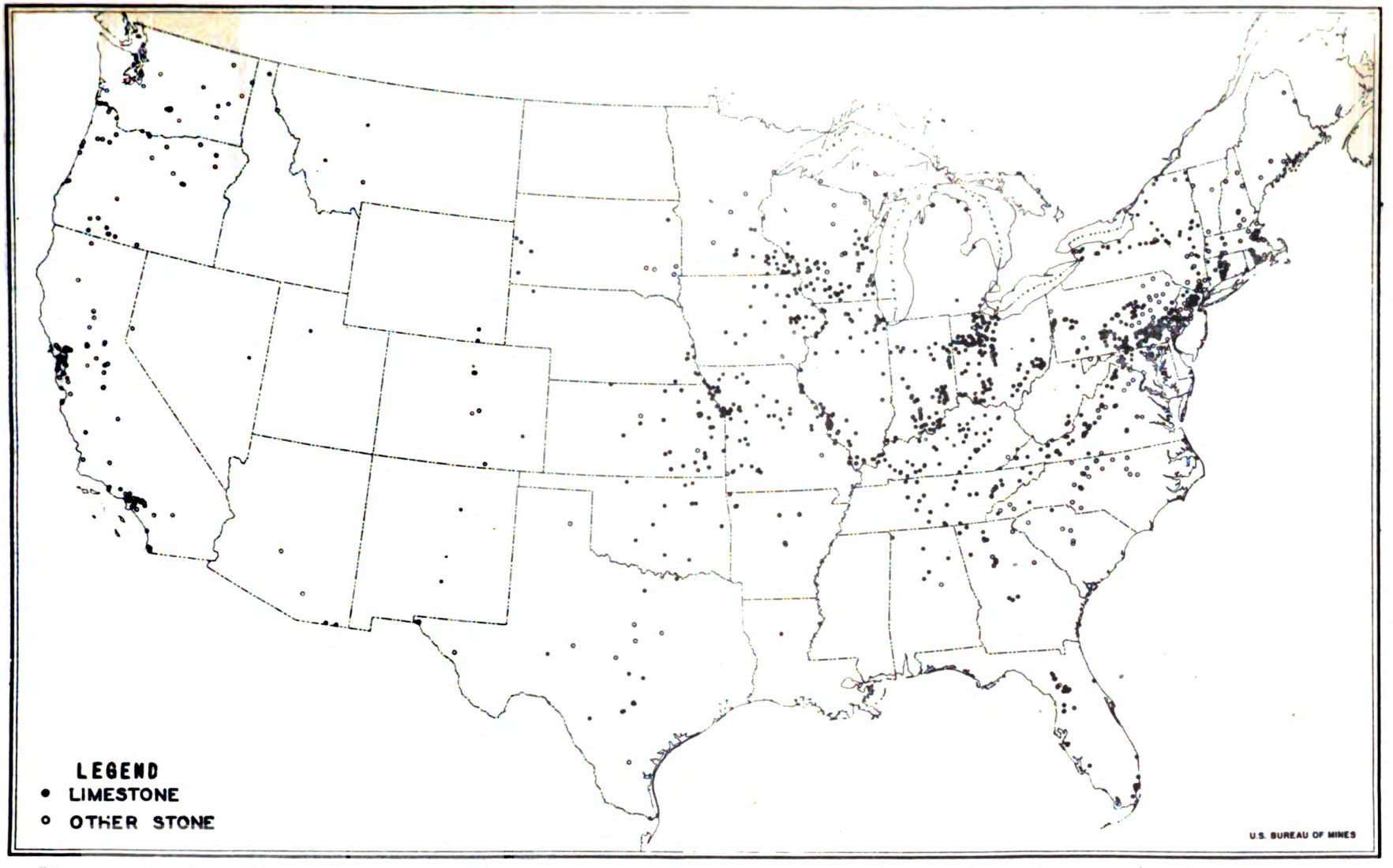

Figure 5.—Location of commercial quarries reporting production of crushed stone for building purposes in 1940.

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CONCLUSIONS

It may be concluded that the sand and gravel industry has not yet reached the top of its spectacular career. New markets are opening constantly, and new uses of the materials are being developed. The National Sand & Gravel Association has been alert to discover new uses and improve old ones. Better adherence to specifications and standards has increased confidence in the industry, and improved machinery and equipment have enabled it to attain an enormous volume of output.

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